Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_

**Unit 2 Lab: The Effect of Pineapple Enzymes on Gelatin**

Ms. Ottolini, PreAP Biology

**Background Information:**

Enzymes are very efficient catalysts for biochemical reactions. They speed up reactions by providing an alternative reaction pathway of lower activation energy. Like all catalysts, enzymes take part in the reaction - that is how they provide an alternative reaction pathway. But they do not undergo permanent changes and so remain unchanged at the end of the reaction. They can only alter the rate of reaction, not the position of the equilibrium. Enzymes are usually highly selective, catalyzing specific reactions only. This specificity is due to the shapes of the enzyme molecules.

**Pineapples**

Pineapple’s lush, tropical sweetness is reason enough to enjoy it any way you can, but this fruit also contains vitamin C and manganese. This fruit’s most promising nutritional asset, though, may be bromelain, a natural enzyme found in both the fruit and the stem. Most of the pineapple consumed in the United States is canned (in the form of juice as well as fruit), but fresh pineapple is much more flavorful, and, despite its tough bristly shell, is easy to prepare.

The fruit probably first grew wild in parts of South America and then spread to the Caribbean, where Columbus encountered it. By 1600, early European explorers had carried pineapples as far as China and the Philippines. In the 18th century, pineapples were taken to the Hawaiian Islands, eventually becoming the major fruit crop. Hawaiian pineapple producers were the first to can the fruit.

**Bromelain**

The pineapple plant contains protein-digesting enzymes called, as a group, bromelain. In the health world, these enzymes are regarded as useful in reducing muscle and tissue inflammation (hence the joint pain and wound-healing possibilities), as well as acting as a digestive aid. In the cooking world, on the other hand, bromelain is regarded as the enemy of the gelatin dessert. If you use fresh pineapple in gelatin, the enzyme eats the protein and the gelatin will not gel—in fact bromelain is measured in units called GDU, or gelatin digesting units. The classic kitchen trick for getting around this pineapple-gelatin incompatibility is to cook the pineapple, thus reducing the power of the bromelain.

Recipes that would highlight the benefits of bromelain start with fresh pineapple (which has two to three times the amount of bromelain as canned pineapple does), and is then subjected to as little heat as possible.

Bromelain is used in meat tenderizers, in hill-proofing beer, manufacturing precooked cereals, in certain cosmetics, and in preparation to treat edema and inflammation.

**Gelatin**

Gelatin, a familiar, ingredient in cooking, is obtained by boiling the skin, tendons, and ligaments of animals. As a result, it contains protein called collagen ( a primary component of joints, cartilage, and nails), and various amino acids (histidine, lysine, leucine, tryptophan, and valine, to name a few). Remember: amino acids are the building blocks of proteins.

Gelatin has long been a key ingredient for providing support for “jelled” deserts, salads, frozen drinks, and soft candies such as Gummi Bears. (In fact, the word gelatin is derived from the Latin “gelatus”, meaning stiff or frozen.)

Scientists have been studying gelatin for centuries. It has no smell or taste of its own, adapting to whatever it is added to. During the Napoleonic Wars, the French, desperate for nutrition sources during the English blockade, reportedly first turned to gelatin as a source of protein (albeit a weak one). Gelatin began its long run as a popular consumable, however, in the 1890’s, when it was first developed and then heavily promoted as a commercial product by Charles Knox, founder of the Knox Gelatin Corporation.

In addition to its famous “jiggly” food uses, gelatin with its flexible, dissolvable structure is also used to manufacture capsules (both hard and “soft-gel”) to hold medications, vitamins, and other dietary supplements. It also has a range of industrial and medical engineering applications: Gelatin is an ingredient in film coatings, medical devices such as artificial heart valves, and in specialized meshes used to repair wounds, to name a few.

**Collagen**

About one quarter of all the protein in your body is collagen. It is a major structural material that forms molecular cables to strengthen the tendons and resilient sheets that support the skin and internal organs. Bones and teeth are made by adding mineral crystals to collagen. Collagen provides structure to our bodies, protecting and supporting the softer tissues and connecting them with the skeleton. But, in spite of its critical function in the body, collagen is a relatively simple protein.

Collagen from livestock animals is a familiar ingredient in cooking. Collagen is a protein, and like most proteins, when heated, it loses all of its structure. The polymer molecule unwinds. Then, when the denatured mass cools down, it soaks up all of the surrounding water like a sponge, forming gelatin.

**Purpose:** In this lab, we will attempt to answer the question given below.

*What form of pineapple juice contains enzymes that digest protein?*

**Materials:**

|  |  |  |
| --- | --- | --- |
| For Every 3 Groups | For Each Group | For Entire Class |
| -1 envelope Knox gelatin  -1 beaker (250 ml size)  -1 glass stirring rod  -100 ml graduated cylinder | -3 test tubes  -1 test tube rack  -4 (1 ml) disposable pipettes  -10 ml graduated cylinder  -Marking pen | -water  -pineapple juices (below)  -hot plate to heat H2O |

**Procedure:**

1. Number and label the test tubes “1-3” and use the initials of a group member to identify your group.
2. Find 2 other groups and prepare 1 package of gelatin in the beaker using 90ml of boiling water and 30 ml of cold water. Stir well with a glass stirring rod until the gelatin is dissolved.
3. Place 3 ml of the designated pineapple juice into each test tube. **Use a separate pipette for each type of juice**. Failure to do so may result in mixing of the juice types and inaccurate results.
   * Tube 1: water only
   * Tube 2: fresh pineapple juice
   * Tube 3: Canned pineapple juice
4. Add 10 ml of gelatin mixture to each test tube. Shake well to ensure proper mixing and place your samples in the refrigerator overnight using a test tube rack.
5. On Day 2, check the contents of each test tube for solidification of the contents and record your observations.

*Note: If solidification occurs, the pineapple enzyme was not functional. It could not break down the gelatin protein.*

**Hypothesis:** Write two hypotheses in “If, then” format in which you predict what will happen if you mix fresh pineapple juice vs. canned pineapple juice with gelatin. Before writing your hypothesis, do some research about the process of canning pineapple. After writing your hypothesis, provide an explanation / rationale for your predictions.

***Fresh Pineapple Juice:***

“If fresh pineapple juice is mixed with gelatin, then…” *(fill in the rest of your hypothesis in the space below)*

***Canned Pineapple Juice:***

“If canned pineapple juice is mixed with gelatin, then…” *(fill in the rest of your hypothesis in the space below)*

***Explanation for Your Predictions:***

**Individual Results:**

|  |  |  |
| --- | --- | --- |
| **Test Tube** | **Juice** | **Describe the test tube contents on Day 2**  **(Solid or Liquid?)** |
| 1 | Water |  |
| 2 | Fresh Pineapple Juice |  |
| 3 | Canned Pineapple Juice |  |
| 4 | Concentrated Pineapple Juice |  |

**Class Results**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test Tube** | **Juice** | **# of lab groups with solid test tube contents on Day 2** | **# of lab groups with liquid test tube contents on Day 2** |
| 1 | Water |  |  |
| 2 | Fresh Pineapple Juice |  |  |
| 3 | Canned Pineapple Juice |  |  |
| 4 | Concentrated Pineapple Juice |  |  |

**Lab Report:** You will be graded on your three conclusion paragraphs only. Below is a description of expectations and a rubric for these three paragraphs.

**Expectations:**

Paragraph #1: REE – Results with Evidence and Explanation

1. Results – Explain how the goals/purpose of the lab were/were not achieved.
2. Evidence – Support answers with numerical data.
3. Explanation – Do the data support or not support (refute) hypothesis?

Paragraph #2: PE – Possible Errors (must have at least 2)

1. Explain experimental design errors that would lead to false data.
2. Recommendations on how to improve the experiment to minimize the error.

Paragraph #3: PA – Practical Applications

1. What have you learned? (this must relate to the results of the experiment)
2. Recommendations for follow up experiments.

**Rubric:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Category** | | **Excellent (5 points)** | **Good (3 points)** | **Needs Improvement (1 point)** |
| **Conclusion** | **A) Results**  **Evidence**  **Explanations** | * Conclusion begins with a clear, concise discussion of the purpose of the experiment or study. * All of the important results are explained in relation to the purpose statement. * The results statement includes (numerical) evidence (including averages) when appropriate. * A clear and concise explanation of how the data supports or refutes expectations or hypotheses is given. | * The purpose of the experiment or study is mentioned but is not clear, concise, and accurate. * Most of the important results are explained in relation to the purpose statement. * The results statement includes evidence that is not numerical when needed. * Some explanation of results is given but no mention of how the data supports or refutes expectations or hypotheses. | * There is no mention of the purpose or the subject of the study. * The results of the experiment or study are not stated. * Little evidence is given for the results of the experiment. * Little explanation of whether the data supports or refutes expectations or hypotheses is given. |
| **B) Possible Errors** | At least two examples of procedural errors or uncertainties that could lead to inaccurate data are identified and explained. Discuss ways to avoid these errors in the future. | Examples of procedural errors or uncertainties are identified but no discussion of ways to avoid these errors. | Unclear examples of procedural errors or uncertainties that could lead to inaccurate data are identified and explained. |
| **C) Practical Applications** | A clear, concise explanation what you learned in this lab (must be related to the RESULTS of the experiment!), and recommendations for follow-up experiments. | An explanation lacking one of the following:  1. What you learned in this lab  2. Recommendations for follow-up experiments | An explanation lacking both of the following:  1. What you learned in this lab  2. Recommendations for follow-up experiments, |

**Total Points** \_\_\_\_\_\_\_/15 points **Grade** \_\_\_\_\_\_\_\_%